Avian influenza control – the merits of vaccination

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The role of vaccination in eradicating or controlling notifiable diseases, such as highly pathogenic avian influenza (HPAI), is a long standing debate.

The preferred method of control is based on the culling of infected poultry and poultry on surrounding farms creating a poultry free buffer zone to prevent the further spread of the virus.

This is an effective disease eradication method when implemented in combination with strict quarantine measures and enhanced biosecurity.

However, the logistics required for the rapid, humane disposal of large numbers of poultry is a challenging task for most countries with an accompanying price tag few can afford.

Vaccination as an additional avian influenza (AI) control measure has been used in a number of countries, including the USA, Mexico, Italy, Pakistan and Hong Kong.

In most cases vaccination was directed at low pathogenic strains, however in Mexico, Pakistan, Italy and Hong Kong vaccination was successfully used to eradicate HPAI.

With the current HPAI epizootic in Asia only China and Indonesia have, to date, included vaccination as part of their AI control strategy.

What are the reasons behind the reluctance to accept vaccination as an additional tool in the control of HPAI?

Avian influenza vaccines

Two vaccine technologies are currently registered and used in the poultry industry; inactivated whole AI virus in an oil adjuvant and a recombinant fowl pox vector vaccine.

The efficacy and safety of both vaccine technologies has been proven, and both require individual bird administration.

The fowl pox vector vaccine is only indicated for use in birds not previously exposed to the poxvirus, limiting administration to day old chickens in most poultry producing regions.

In global terms the most AI vaccination experience is based on inactivated AI virus in an oil adjuvant.

Masking the disease

One of the primary concerns about vaccination is the potential to mask the disease, allowing vaccinated flocks to act as reservoirs for continued virus circulation.

Experimental results from various laboratories and recent field experience reported from Hong Kong have consistently shown that vaccinated birds are less likely to become infected and in case of infection will excrete lower quantities of virus, usually a reduction of at least ten thousand times in comparison to non-vaccinated controls (Fig. 1).

From Hong Kong there are reports of the successful elimination of HPAI from farms in the face an outbreak using a combination of selective culling and vaccination.

Shut down of virus excretion was demonstrated 13-18 days subsequent to a single dose of inactivated AI vaccine.

Vaccination reduces the overall AI virus load and the number of birds infected with the virus, thus controlling spread of the disease.

Further to this, a decreased AI virus load reduces the risk of infection faced by humans who come in contact with infected poultry, a public health factor of international concern.

Selecting for mutant strains

Concerns have been expressed that vaccination may select for mutant strains of the HPAI virus. It is well recognised that influenza viruses naturally undergo spontaneous mutation whenever they are allowed to multiply.

Studies of Asian H5N1 viruses isolated in the period from 1996 to 2004 demonstrated the presence of significant genetic variations among isolates even before the introduction of AI vaccines to the region.

It can be expected that vaccination may actually reduce the opportunity for natural mutation by reducing the quantity of circulating virus.

Work done in the USA has demonstrated that a perfect match between field and vaccine strains is not required.

There is good cross protection between AI strains belonging to the same AI haemagglutinin (HA) subtype.

Nonetheless, when a decision is made to vaccinate this should always be accompanied by continuous monitoring for circulating AI field strains.

If on further analysis any changes are detected, likely to reduce the effectiveness of the AI vaccines in use, appropri-

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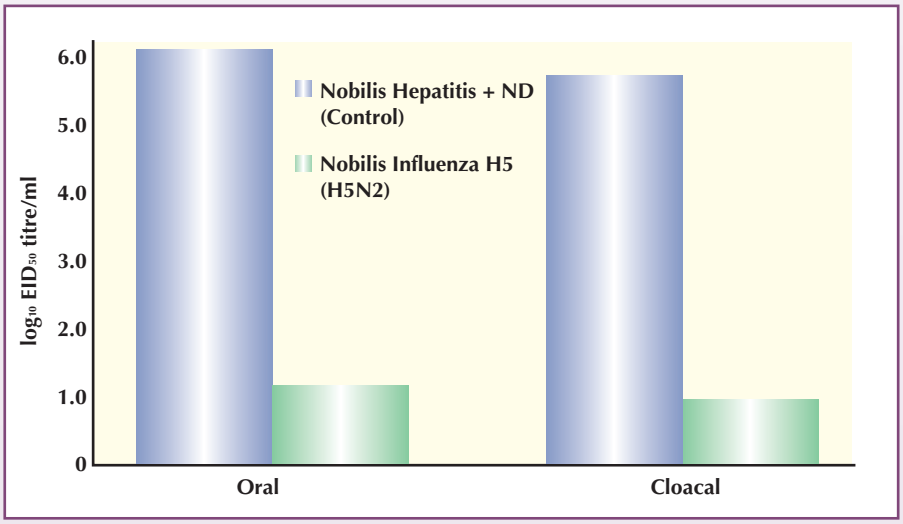
Fig. 1. Significant decrease in the quantity of HPAI virus shed from vaccinated chickens compared to unvaccinated controls. SPF chickens vaccinated at three weeks of age. Challenged with HPAI H5N1 (Asia 2003) three weeks post vaccination. Virus isolation two days post challenge. (Dr D. Swayne DVM, PhD, Southeast Poultry Research Laboratory, USDA/ARS, Athens, Georgia).



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ate steps should be taken to update the vaccine strains.

Vaccination – an additional tool

Whether vaccination is used or not must be evaluated on a case by case basis following a thorough risk analysis. It is unlikely that a decision would be made to vaccinate if an isolated flock of chickens became infected, but should this flock be located in an area with a high density of poultry the arguments may swing in favour of vaccination as an additional control measure.

Outbreaks of AI

The success of AI eradication is dependent on the rapid diagnosis of the virus and quarantining the area to prevent further spread. Vaccination has a secondary role creating a buffer zone around the affected area, a second line of defence in case of a breech in the efficacy of the primary quarantine zone.

This AI eradication model has been successfully implemented in China. A stamping out and zero movement policy is enforced in the immediate zone surrounding an infected farm.

A second surrounding zone is declared in which all poultry is vaccinated against AI and in a final outer zone all live bird markets are shutdown (Fig. 2).

Stamping out is thus limited to infected poultry and the most immediate risk flocks. Vaccination establishes a surrounding buffer and closing markets effectively removes the incentive to move poultry.

As it takes 2-3 weeks post vaccination to develop effective immunity, it goes without saying that the effectiveness of this scheme hinges on the immediate availability of vaccine.

This requires the establishment of vaccine stockpiles or antigen banks.

Serotype specificity dictates that at least one strain each of the two primary subtypes responsible for HPAI (H5 and H7) need to be available in sufficient quantities.

Endemic situations

In an endemic situation, as currently experienced in parts of Asia, the virus has become established; there is a high risk for infection. Control requires two focuses. Improving biosecurity and farming practices to limit the risk of infection and vaccination.

Vaccination is an interim measure to ease the negative economic impact of the disease and to reduce virus load in the environment, in so doing reducing the potential human health risk.

Vaccination zones within a country and the policy on which groups of poultry to vaccinate (layers, ducks, native breeds) should be determined on an individual case basis following a thorough risk analysis.

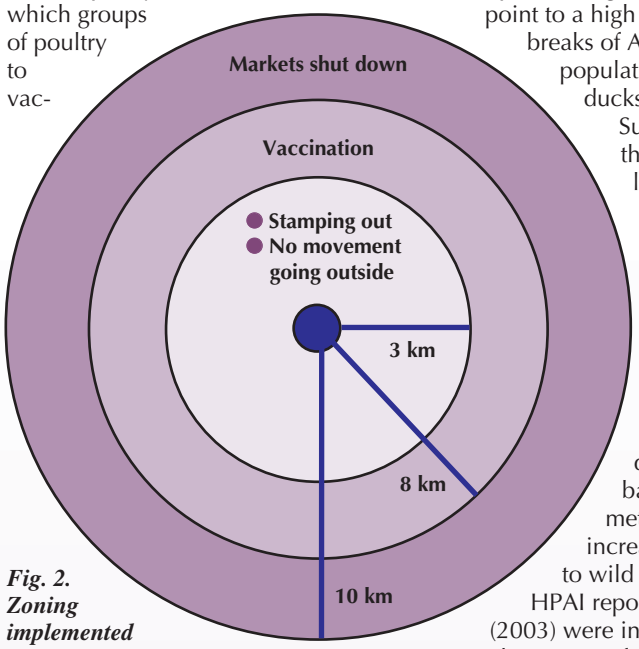

Fig. 2. Zoning implemented by China. Centre represents infected farm (FAO Empres Transboundary Animal Diseases Bulletin 25).

It may, for example, not be indicated to vaccinate poultry raised in the well organised commercial sector with a high standard of biosecurity and closed housing systems.

However, vaccination of poultry in more traditional rural settings with free range or poorer housing facilities, less attention to biosecurity and the free movement of live birds to and from markets may well be beneficial.

Strategic vaccination

A well established AI virus pool in the wild bird population, especially aquatic species, means worldwide eradication of AI is not feasible.

Farming with domestic poultry must adapt to manage the risk.

The first and most effective control point is limiting contact between domestic poultry and wild birds, easily achieved with intensive poultry husbandry methods; closed housing systems create an effective barrier.

On the contrary, free range poultry are continuously at risk of exposure to new AI strains.

In Asia domestic ducks and geese share paddy fields with wild birds, a high risk situation further compounded by the fact that domestic ducks and geese excrete virus despite rarely showing clinical signs of AI infection.

Epidemiological studies in the region point to a high correlation between outbreaks of AI in chickens and the population density of domestic ducks.

Surveys have confirmed that the virus is well established in the domestic duck population suggesting that this has become the most likely source of re-infection for other domestic poultry.

In Western markets the consumer demand for 'green' produce is driving animal husbandry towards free range methods, which for poultry increases the risk of exposure to wild birds. The first cases of HPAI reported in the Netherlands (2003) were in free range laying flocks. The source of the infection was never established and extensive serological surveys produced no evidence of previously circulating related AI viruses in the Dutch poultry population, suggesting probable introduction from a wild bird source.

Vaccination may have an important role to play in securing free range poultry. Immunising birds against selected AI serotypes (H5 and H7) would limit the risk of HPAI becoming established in free range flocks following an incidental exposure from a wild bird source.

Global acceptance of vaccination

Vaccination is a legitimate tool for inclusion in AI control strategies, both in complementing eradication strategies and in preventing the infection of high risk poultry flocks.

In a well vaccinated poultry flock AI is less likely to become established and in case of infection there is a significant reduction in the quantity of virus shed reducing the risk of further spread to neighbouring flocks.

However, for global acceptance of vaccination much research is still required to improve monitoring systems capable of effectively discriminating between vaccinated flocks and field infections.

Demonstrating that an area is free of circulating AI virus strains is an important factor for international poultry trade.

Locally monitoring for the prevalence of circulating AI viruses in vaccinated flocks is important to evaluate the efficacy of control strategies. ■